NE 610 - Final Exam

All problems will have the following characteristics unless otherwise stated.

a. 1-D spherical geometry.

b. Sphere radius = 25 cm.

c. Spatial zoning = 100 uniform cells.

d. Constant isotropic distributed source (Q_0 $p/(cm^3 - sec)$).

e. Incident isotropic flux at right boundary ($\frac{\phi_0}{4\pi}$).

f. Reflective condition at left boundary (center of the sphere).

1. Using diffusion theory with Marshak boundary conditions and S_2, S_4 and S_8 theory with Gauss quadrature, calculate the scalar flux for the model problem with a unit isotropic boundary flux, $2\pi \int_{-1}^{0} \frac{\phi_0}{4\pi}|\mu|\, d\mu = 1$, no distributed source, $\sigma_t = 1.0\ cm^{-1}$, and $\sigma_a = 0.0\ cm^{-1}$. Plot the scalar flux solutions as a function of space and explain the results. (All three plots should be placed in one figure.)

2. Same as Problem 1, except that the boundary flux is zero (i.e., a vacuum boundary condition at the outer surface), and the distributed source, $Q_0 = 1$.

3. Same as Problem 2, but with $\sigma_t = 0.1\ cm^{-1}$. First perform the calculation using standard weighted-diamond angular differencing and then repeat the calculation using step angular differencing. The standard reflective boundary condition should be used at the origin with step differencing.

4. Using diffusion theory with Marshak boundary conditions and S_{16} theory with Gauss quadrature, calculate the scalar flux for the model problem with a unit distributed source ($Q_0 = 1\ p/(cm^3 - sec)$), a vacuum boundary condition at the outer surface, $\sigma_t = 0.1\ cm^{-1}$ and $\sigma_a = 0.05\ cm^{-1}$. Then repeat the calculation with $Q_0 = 0.1$, $\sigma_t = 1.0$, and $\sigma_a = 0.005$. Finally, repeat the calculation with $Q_0 = 0.01$, $\sigma_t = 10.0$, and $\sigma_a = 0.0005$. Plot the solutions and explain the results. (All three plots should be placed in one figure.)

5. Using S_{16} theory with Gauss quadrature, calculate the scalar flux for the model problem with a unit isotropic distributed source ($Q_0 = 1\ p/(cm^3 - sec)$), a vacuum condition at the outer surface, and $\sigma_t = \sigma_s = 1.0\ cm^{-1}$. Then repeat the calculation with $\sigma_t = \sigma_s = 1.5\ cm^{-1}$, and $\sigma_1 = 0.5\ cm^{-1}$. Finally, repeat the calculation with $\sigma_t = \sigma_s = 1.5\ cm^{-1}$ and $\sigma_1 = \sigma_2 = \ldots = \sigma_{15} = 0.5\ cm^{-1}$. Plot the scalar flux solutions and explain the results. (All three plots should be placed in one figure.)